ADSORPSI Cr(VI) MENGGUNAKAN ADSORBEN Fe_3O_4/SiO_2/KITOSAN DENGAN ABU LIMBAH PEMBAKARAN BATU BATA SEBAGAI SUMBER SILIKA

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INTISARI

Telah dilakukan penelitian mengenai optimasi ekstraksi silika dari abu limbah pembakaran batu bata, sintesis material silika magnetit (SM) dan Fe_3O_4/SiO_2/kitosan (SMK) sebagai adsorben Cr(VI). Beberapa faktor yang mempengaruhi proses ekstraksi silika dari abu limbah pembakaran batu bata telah dipelajari, termasuk pengaruh pencucian abu dengan HCl, konsentrasi NaOH dalam proses ekstraksi dan waktu pemanasan. Faktor yang mempengaruhi proses adsorpsi seperti komposisi SM/kitosan dalam SMK, pH, waktu kontak dan konsentrasi Cr(VI) juga telah dipelajari.

Optimasi ekstraksi silika dilakukan dengan rancangan percobaan Taguchi ortogonal. Pembuatan adsorben SM diawali dengan pembuatan material magnetit menggunakan metode kopresipitasi dilanjutkan dengan hidrolisis natrium silikat. Modifikasi adsorben SM dengan kitosan dilakukan dengan variasi komposisi massa SM/kitosan 1:0,5; 1:1 dan 1:2. Adsorben yang terbentuk dikarakterisasi menggunakan FTIR, XRD dan pengujian ketahanan adsorben terhadap medium asam. Studi adsorpsi-desorpsi dilakukan dengan sistem tumpak. Konsentrasi Cr(VI) ditentukan secara spektrofotometri UV-Vis. Penggunaan kembali adsorben dipelajari dari tiga siklus proses adsorpsi-desorpsi.

Analisis rancangan Taguchi menunjukkan bahwa kondisi optimum ekstraksi diperoleh pada konsentrasi HCl pencucian awal 6 M, konsentrasi NaOH 4 M dan waktu pemanasan selama 3 jam. Karakterisasi FTIR dan XRD menunjukkan adsorben berhasil disintesis. Pengujian ketahanan asam menunjukkan SM dan SMK lebih tahan terhadap asam dibandingkan dengan magnetit. Komposisi SM/kitosan terbaik untuk adsorpsi Cr(VI) diperoleh pada perbandingan 1:1. Nilai pH, waktu dan konsentrasi Cr(VI) optimum untuk SM diperoleh pada pH 2, waktu 90 menit dan konsentrasi Cr(VI) 20 mg L^{-1}; sedangkan untuk SMK diperoleh pada pH 3, waktu 90 menit dan konsentrasi Cr(VI) 150 mg L^{-1}. Kinetika dan isoterm adsorpsi dari kedua adsorben mengikuti model kinetika orde dua semu dan isoterm Langmuir. Regenerasi SMK menunjukkan penurunan kapasitas adsorpsi setelah tiga siklus adsorpsi-desorpsi.

Kata kunci : Abu limbah batu bata, SiO_2, Fe_3O_4, kitosan, adsorpsi Cr(VI).

ADSORPTION OF Cr(VI) USING Fe_3O_4/SiO_2/CHITOSAN ADSORBENT WITH ASH OF BRICK COMBUSTION WASTE AS SILICA SOURCE

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ABSTRACT

A research of silica extraction from ash of bricks combustion, synthesis of silica magnetite (SM) and chitosan modified SM (SMK), as well as the adsorption-desorption study of Cr(VI) on both adsorbents have been conducted. Some factors that affected silica extraction were studied, including HCl concentration for washing ash, NaOH concentration for extraction, and the reaction time. Effects of SM/chitosan composition, pH, contact time, and concentration of Cr(VI) on the adsorption properties of adsorbent were analyzed.

Silica extraction was optimized by applying the Taguchi orthogonal arrays design. Synthesis of SM adsorbent was started with preparation of magnetite using co-precipitation method and was followed by hydrolysis of sodium silicate. Modification of SM with chitosan was done by varying mass composition of SM/chitosan 1:0.5; 1:1; 1:2. The obtained adsorbents were characterized with XRD, FT-IR, and for its leaching test to evaluate the stability under acid condition. The adsorption-desorption was done by using batch system. The concentrations of Cr(VI) were determined spectrophotometrically. Reusability of SMK was investigated by 3 cycles of adsorption-desorption process.

Analysis of Taguchi design showed that the optimal conditions for silica extraction were formed by a HCl concentration of 6 M, NaOH concentration of 4 M, and reaction time of 3 hours. The characterization results showed that adsorbents had been successfully synthesized. Leaching test indicated that SMK had better tolerance to acid medium and exhibited higher removal efficiency for Cr(VI) than SM did. The best composition of SM/chitosan for Cr(VI) removal was 1:1. The best conditions for SM and SMK were obtained at pH 2 and 3. Both adsorbents had optimum contact time at 90 minutes and followed the pseudo second order with Langmuir isotherm. SMK adsorption capacity for Cr(VI) was reduced from 98.44 mg g^{-1} to 34.07 mg g^{-1} after 3 times of reuse.

Keywords: ash of brick waste, SiO_2, Fe_3O_4, chitosan, Cr(VI) adsorption.